

## CLAIMS

What is claimed is:

1. A method of making a stabilized transition alumina catalyst support comprising:
  - (a) introducing to a transition alumina at least one structural stabilizer precursor to provide a stabilizer-impregnated alumina;
  - (b) optionally, drying the stabilizer-impregnated alumina;
  - (c) steaming the stabilizer-impregnated alumina at conditions sufficient to at least partially transform the stabilizer-impregnated alumina to a stabilizer-containing boehmite alumina; and
  - (d) calcining the stabilizer-containing boehmite alumina.
2. The method according to claim 1 wherein the transition alumina comprises a phase selected from the group consisting of  $\gamma$ -Al<sub>2</sub>O<sub>3</sub>,  $\delta$ -Al<sub>2</sub>O<sub>3</sub>,  $\theta$ -Al<sub>2</sub>O<sub>3</sub> and any combination thereof.
3. The method according to claim 1 wherein the transition alumina comprises a  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> phase.
4. The method according to claim 1 wherein the stabilized transition alumina comprises a phase selected from the group consisting of  $\gamma$ -Al<sub>2</sub>O<sub>3</sub>,  $\delta$ -Al<sub>2</sub>O<sub>3</sub>,  $\theta$ -Al<sub>2</sub>O<sub>3</sub> and any combination thereof.
5. The method according to claim 1 wherein the stabilized transition alumina comprises a  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> phase.

6. The method according to claim 1 wherein the at least one structural stabilizer precursor comprises at least one element selected from the group consisting of boron, magnesium, silicon, calcium, titanium, chromium, manganese, iron, cobalt, nickel, copper, zinc, gallium, strontium, zirconium, barium, selenium and the lanthanides, including lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium.

7. The method according to claim 1 wherein the at least one structural stabilizer precursor comprises at least one element selected from the group consisting of boron, cobalt, zirconium and combinations thereof.

8. The method according to claim 1 wherein at least two structural stabilizer precursors are introduced to a transition alumina.

9. The method according to claim 1 wherein the at least one structural stabilizer precursor is introduced in a manner and an amount effective for delivering an amount of structural stabilizer precursor between 0.1% and 20% by weight of structural stabilizer precursor relative to a final weight of the stabilized transition alumina.

10. The method according to claim 1 wherein the at least one structural stabilizer precursor is introduced in a manner and an amount effective for delivering an amount of structural stabilizer

precursor between 1% and 10% by weight of structural stabilizer precursor relative to the final weight of a stabilized transition alumina.

11. The method according to claim 1 wherein the at least one structural stabilizer precursor is introduced in a manner and an amount effective for delivering an amount of structural stabilizer precursor between 1% and 5% by weight of structural stabilizer precursor relative to a final weight of the stabilized transition alumina.

12. The method according to claim 1 wherein step (a) is carried out using at least one technique of impregnation, ion-exchange, grafting and kneading.

13. The method according to claim 1 wherein the method includes step (b), and wherein step (b) is carried out at a temperature between 50 °C and 200 °C.

14. The method according to claim 1 wherein step (c) comprises at least partially transforming the stabilizer-impregnated alumina to at least one phase selected from the group consisting of boehmite, pseudoboehmite, and the combination thereof.

15. The method according to claim 1 wherein the sufficient conditions of step (c) comprise a temperature between 150° C and 500° C.

16. The method according to claim 1 wherein the sufficient conditions of step (c) comprise a water vapor partial pressure between 1 bar and 5 bars.

17. The method according to claim 1 wherein the sufficient conditions of step (c) comprise a water vapor partial pressure between 2 bars and 4 bars.
18. The method according to claim 1 wherein step (d) is carried out at a temperature between 300° C and 1,000° C.
19. The method according to claim 1 wherein step (d) is carried out at a temperature between 400° C and 900° C.
20. A method of making a stabilized transition alumina catalyst support comprising:
- (a) steaming a transition alumina at conditions sufficient to at least partially transform the transition alumina to a boehmite alumina;
  - (b) introducing to the boehmite alumina at least one structural stabilizer precursor to provide a stabilizer-containing boehmite alumina;
  - (c) optionally, drying the stabilizer-containing boehmite alumina; and
  - (d) calcining the stabilizer-containing boehmite alumina.
21. The method according to claim 20 wherein the transition alumina comprises a phase selected from the group consisting of  $\gamma$ -Al<sub>2</sub>O<sub>3</sub>,  $\delta$ -Al<sub>2</sub>O<sub>3</sub>,  $\theta$ -Al<sub>2</sub>O<sub>3</sub> and any combination thereof.
22. The method according to claim 20 wherein the transition alumina comprises a  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> phase.

23. The method according to claim 20 wherein the stabilized transition alumina comprises a phase of  $\gamma$ - $\text{Al}_2\text{O}_3$ ,  $\delta$ - $\text{Al}_2\text{O}_3$ ,  $\theta$ - $\text{Al}_2\text{O}_3$  or any combination thereof.
24. The method according to claim 20 wherein the stabilized transition alumina comprises a  $\gamma$ - $\text{Al}_2\text{O}_3$  phase.
25. The method according to claim 20 wherein step (a) comprises at least partially transforming the transition alumina to at least one phase selected from the group consisting of boehmite, pseudoboehmite, and the combination thereof.
26. The method according to claim 20 wherein the sufficient conditions of step (a) comprise a temperature between 150° C and 500° C.
27. The method according to claim 20 wherein the sufficient conditions of step (a) comprise a water vapor partial pressure between 1 bar and 5 bars.
28. The method according to claim 20 wherein the sufficient conditions of step (a) comprise a water vapor partial pressure between 2 bars and 4 bars
29. The method according to claim 20 wherein the sufficient conditions of step (a) comprise a temperature between 150° C and 500° C; a water vapor partial pressure between 1 bar and 5 bar; and an interval of time between 0.5 hours and 10 hours.

30. The method according to claim 29 wherein the transition alumina is at least partially transformed to at least one phase selected from the group consisting of boehmite, pseudoboehmite and the combination thereof.

31. The method according to claim 20 wherein the at least one structural stabilizer precursor comprises at least one element selected from the group consisting of boron, magnesium, silicon, calcium, titanium, chromium, manganese, iron, cobalt, nickel, copper, zinc, gallium, strontium, zirconium, barium, selenium and the lanthanides, including lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium.

32. The method according to claim 20 wherein the at least one structural stabilizer precursor comprises at least one element selected from the group consisting of boron, cobalt, zirconium, and combinations thereof.

33. The method according to claim 20 wherein at least two structural stabilizer precursors are introduced to a boehmite alumina.

34. The method according to claim 20 wherein step (b) is carried out using at least one technique of impregnation, ion-exchange, grafting and kneading.

35. The method according to claim 20 wherein the at least one structural stabilizer precursor is introduced in a manner and an amount effective for delivering an amount of structural stabilizer precursor between 0.1% and 20% by weight of structural stabilizer precursor relative to a final weight of the stabilized transition alumina.

36. The method according to claim 20 wherein the at least one structural stabilizer precursor is introduced in a manner and an amount effective for delivering an amount of structural stabilizer precursor between 1% and 10% by weight of structural stabilizer precursor relative to a final weight of a stabilized transition alumina.

37. The method according to claim 20 wherein the at least one structural stabilizer precursor is introduced in a manner and an amount effective for delivering an amount of structural stabilizer precursor between 1% and 5% by weight of structural stabilizer precursor relative to a final weight of the stabilized transition alumina.

38. The method according to claim 20 wherein the method includes step (c), and wherein step (c) comprises a temperature between 50° C and 200° C.

39. The method according to claim 38 wherein step (c) is executed after step (b).

40. The method according to claim 20 wherein step (d) is carried out at a temperature between 300° C and 1,000° C.

41. The method according to claim 20 wherein step (d) is carried out at a temperature between 400° C and 900° C.

42. A method for preparing a Fischer-Tropsch catalyst comprising:

(a) introducing at least one catalytic metal precursor to a stabilized transition alumina catalyst support to provide a catalyst-impregnated support;

(b) optionally, introducing at least one cocatalytic metal precursor to the catalyst-impregnated support to provide a cocatalyst-impregnated support;

(c) optionally, introducing at least one promoter precursor to the cocatalyst-impregnated support to provide a promoter-impregnated support;

(d) optionally, drying the catalyst-impregnated support at conditions effective for removing any solvents used in introducing at least one of the precursors of steps (a), (b) and (c), wherein drying provides a dried catalyst-impregnated support; and

(e) calcining the catalyst-impregnated support at conditions effective for decomposing at least one of the precursors of steps (a), (b) and (c) to the corresponding oxides.

43. The method according to claim 42 wherein the at least one catalytic metal precursor comprises at least one metal selected from the group consisting of cobalt, iron, ruthenium and nickel.

44. The method according to claim 42 wherein the at least one catalytic metal precursor comprises cobalt.



45. The method according to claim 42 wherein the at least one catalytic metal precursor is added in an amount sufficient for delivering an amount of catalytic metal to the stabilized transition alumina catalyst support that is between 5% and 50% by weight of catalytic metal relative to a weight of the support.

46. The method according to claim 42 wherein the at least one catalytic metal precursor is added in an amount sufficient for delivering an amount of catalytic metal to the stabilized transition alumina catalyst support that is between 10% and 40% by weight of catalytic metal relative to a weight of the support.

47. The method according to claim 42 wherein the at least one catalytic metal precursor is added in an amount sufficient for delivering an amount of catalytic metal to the stabilized transition alumina catalyst support that is between 15% and 35% by weight of catalytic metal relative to a weight of the support.

48. The method according to claim 42 wherein at least one of the precursors is introduced using a technique selected from the group consisting of incipient wetness impregnation, melt impregnation and coprecipitation.

49. The method according to claim 42 wherein the at least one cocatalytic metal precursor in step (b) comprises at least one metal of Groups IIIA, IVA, VA, VIA, VIIA, VIIIA, IB and IIB.

50. The method according to claim 42 wherein the at least one cocatalytic metal precursor in step (b) comprises at least one metal selected from the group consisting of ruthenium, hafnium, cerium, copper, thorium, zirconium, rhenium and titanium.

51. The method according to claim 42 wherein the at least one cocatalytic metal precursor in step (b) is added in an amount sufficient for delivering an amount of cocatalytic metal to the catalyst-impregnated support that is between 0.001% and 20% by weight of the cocatalytic metal relative to a weight of the support.

52. The method according to claim 42 wherein the at least one cocatalytic metal precursor in step (b) is added in an amount sufficient for delivering an amount of cocatalytic metal to the catalyst-impregnated support that is between 0.005% and 10% by weight of the cocatalytic metal relative to a weight of the support.

53. The method according to claim 42 wherein the at least one cocatalytic metal precursor in step (b) is added in an amount sufficient for delivering an amount of cocatalytic metal to the catalyst-impregnated support that is between 0.01% and 5% by weight of the cocatalytic metal relative to a weight of the support.

54. The method according to claim 42 wherein the at least one promoter precursor in step (c) comprises at least one element selected from Groups IA, IIA, IIIB, IVB, VB, VIB and VIIB.

55. The method according to claim 42 wherein the at least one promoter precursor in step (c) comprises at least one element selected from boron, palladium, platinum, silver, gold, nickel, copper, the alkali metals, the alkaline earth metals, the actinides and the lanthanides.

56. The method according to claim 42 wherein the at least one promoter precursor in step (c) comprises boron.

57. The method according to claim 42 wherein the at least one promoter precursor in step (c) is added in an amount sufficient for delivering an amount of promoter to the stabilized transition alumina catalyst support that is between 0.005% and 20% by weight of the promoter relative to a weight of the support.

58. The method according to claim 42 wherein the at least one promoter precursor in step (c) is added in an amount sufficient for delivering an amount of promoter to the stabilized transition alumina catalyst support that is between 0.01% and 10% by weight of the promoter relative to a weight of the support.

59. The method according to claim 42 wherein the at least one promoter precursor in step (c) is added in an amount sufficient for delivering an amount of promoter to the stabilized transition alumina catalyst support that is between 0.02% and 5% by weight of the promoter relative to a weight of the support.

60. The method according to claim 42 wherein the effective conditions of step (e) comprise a temperature between 200° C and 500° C.
61. The method according to claim 42 wherein the effective conditions of step (e) comprise a temperature between 300°C and 400° C.
62. The method according to claim 42 wherein the effective conditions of step (e) comprise a pressure between 1 atm and 10 atm.
63. The method according to claim 42 wherein the effective conditions of step (e) comprise a pressure between 1 atm and 5 atm.
64. The method according to claim 42 wherein the effective conditions of step (e) comprise a pressure of 1 atm.
65. The method according to claim 42 wherein at least one of steps (a), (b), (c), (d), and (e) is executed more than once.
66. The method according to claim 42 wherein any combination of steps (a), (b) and (c) are executed concurrently.
67. The method according to claim 42 wherein step (c) is carried out simultaneous with step (a).

68. The method according to claim 42 wherein step (c) is carried out simultaneous with step (b).

69. The method according to claim 42 wherein step (b) is carried out more than once.

70. A process for producing a product mixture comprising paraffinic hydrocarbons, comprising:

contacting a reactant gas mixture comprising synthesis gas with a catalyst under conditions and in a reactor effective for at least partially transforming the synthesis gas to the product mixture, wherein the catalyst comprises

a stabilized transition alumina catalyst support,

wherein the support comprises at least one stabilized transition alumina,

wherein the stabilized transition alumina is characterized by the presence of at least one structural stabilizer,

wherein the at least one structural stabilizer is selected from the group consisting of boron, magnesium, silicon, calcium, titanium, chromium, manganese, iron, cobalt, nickel, copper, zinc, gallium, strontium, zirconium, barium, selenium and the lanthanides, including lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium,

wherein the stabilized transition alumina catalyst support is made by steaming before or after the incorporation of the structural stabilizer;

at least one catalytic metal;  
optionally at least one cocatalytic metal;  
and optionally at least one promoter.

71. The process according to claim 70 wherein the process is effective for producing the product mixture having an alpha value of at least 0.85.

72. The process according to claim 70 wherein the process is effective for producing a product mixture comprising primarily hydrocarbons of at least 5 carbon atoms.